Topic: SP.3 – Toward a new scenario of the Messinian Salinity Crisis

Exhumation and update of a 25 year old data bank on the Messinian in Italy

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The end product of a three years long research project on the distribution of Messinian age sediments in Italy, carried out by the Operational Unit 5.2.10 of the Progetto Finalizzato Geodinamica CNR, is represented by a data bank and a series of graphic outputs published in 1983 in a 467 pages long volume. Publication n. 514 described 610 subsurface sections from commercial wells and 245 measured sections from land. Outputs included graphic logs and a number of maps, originally produced at the scale of 1:1.500.000, showing the location of the sections or wells, the presence of the various units identified, and their thickness. Maps showing numerical data were presented as mean values per surface unit, each unit being 10' x 10' wide (~320 km^2). Most of the data presented, with special reference to the commercial wells, were unpublished. But now, 25 years later, they may well be discussed openly, revealing their terrific geodynamic implications. The short duration of the Messinian Salinity Crisis (MSC), now astrochronologically calibrated with unprecedented precision (initiation of the crisis at 5.96 Ma, intra-Messinian unconformity at 5.62, initiation of the Lago-mare biofacies at 5.41 Ma, termination of the crisis at 5.33 Ma) in agreement with the 0.5 my estimated in 1983, is such that these computer generated maps can still provide a number of paleogeographic information and contain a strong geodynamic message. Important variations in thickness are recorded in the various lithologic units referred to the Messinian. Total thickness ranges from negative, where erosional gaps exist (i.e. at the foot of the Alps) to over 1000 m. High thicknesses are recorded in two different situations: at the depocenter of backarc and wedge-top evaporitic basins and in the Apennine foredeep, where sedimentation was essentially not evaporitic and/or with clastic gypsum. The top of the Messinian formations (the Miocene/Pliocene boundary) documented in wells and land outcrops has a vertical range in excess of 7000 m. The minimum elevation recorded is -5365 m a.s.l. in the area of the Po delta. The maximum elevation is 1806 m a.s.l. in central Apennines. In Sicily the elevation of the top of the Messinian (base of the Pliocene) ranges from -1156 m to 721 m a.s.l. (mean value per surface unit). A number of new information is now available as a result of exploration and/or production wells and surface exposures obtained in the last 25 years. We present an updated view for the northern Italy limited to the Po Pain and the southern border of the Alps. ENI geologists greatly contributed to the subsurface geology thanks to the interpretation of over 30000 km of seismic profiles and 1800 wells. New contributions include:

- individuation of superimposed buried paleosols, indicative of different paleoclimate conditions in the Messinian succession cored in the Malossa field
- persistent occurrence of dinoflagellates of paratethyian affinity (*Galeacysta etrusca* zone) in the post-evaporitic Messinian
- evaluation of the Messinian sea level drop reconstructed by the geometry of the depositional architecture in the Venetian basin
- new stratigraphic data from land exposures in the Venetian-Friulian Basin and in the Lake Garda area

From a geodynamic point of view, the Po basin is the foredeep of the Apennine chain (accretionary complex) but it has been also the foreland basin of the south-verging Alps. In a broader geodynamic perspective the Mediterranean is a small ocean basin, that as a result of plate motions lost its connections with the Indian Ocean in Middle Miocene times, becoming an W-E elongated gulf tributary of the Atlantic Ocean. Being surrounded by orogenic belts active in Neogene times and crossed by the Maghrebian-Apenninic chain where it reaches its greater N-S width (~1200 km), the Mediterranean basin behaves as an amplifier of the climatic signal with occasional catastrophic episodes, as the MSC. The rate of deposition during the short-lived stage of maximum dessication was three order of magnitude greater than both prior and after the crisis. This is by far the greatest sea level drop registered in the entire history of our planet (1500 m in a few thousands years) causing the deposition of one million km^3 of salts, the annihilation of the entire marine fauna living in the Mediterranean basin prior to its dessication, the deep entrenchment of the major rivers that had to adapt their course to the substantial change undergone by base level of erosion, the creation of erosional surfaces on the passive-type basin margins (as the south-verging Alps in Late Miocene times).
The Adriatic sea is now the shallowest basin of the Mediterranean, but in Messinian times it was the deep, rapidly subsiding depocenter of the Apenninic foredeep. Its NW prolongation extended as far as the foot the Western Alps arc, in the Piedmont basin, some 600 km far from the present day coastline. There, the marine fossiliferous sediments of early Messinian and early Pliocene age indicate bathyal depths, but Messinian evaporites are recorded (in outcrops and/or in wells) only in the Apennine side. The Alpine margin is conversely characterized by erosional surfaces (sequence boundaries) and lacustrine sediments. The hydrologic budget that is now, and supposedly was in Messinian times, strongly negative in the Mediterranean basin, could well be positive in this northernmost portion, where the Alpine chain reached elevations even greater than the present ones, and the connection with the NNW-SSE trending sector of the Apennine foredeep was prevented by the “dorsale ferrarese” structure.
The coherent picture deriving by the old, large data bank and the new acquisitions suggest that a lake was in existence in the depocenter of the Apenninic foredeep, with some connections with the Paratethyan basins to the east. The water table of the lake was some hundreds (300-500 m) meters below the level of the global ocean. Sedimentary composition indicates that the source area was from the north, not from the west (as it is nowadays). The same is true for the northern Adriatic, where provenance of the clastics is from the north (Eastern Alps), not from the west (Western and Central Alps). Recent studies proved that the influence of the Po drainage system likely started only in the early-middle Pleistocene.
Lithogenesis, orogenesis, and morphogenesis are different processes that in general occur in successive phases. The Messinian events are so drastic and short-lived that their reconstruction requires a number of precise observational data but also a broad 3D perspective. Isopach map reconstructions are planned to reach the goal of a fully acceptable interpretation.

Keywords: Messinian Salinity Crisis, data bank, Po Plain